INDOOR AIR QUALITY ASSESSMENT

Luther Burbank Middle School
1 Hollywood Drive
Lancaster, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Emergency Response/Indoor Air Quality Program

August 2005

Background/Introduction

At the request of the Massachusetts Teachers Association (MTA), the Massachusetts Department of Public Health's (MDPH) Center for Environmental Health (CEH), conducted an indoor air quality assessment at the Luther Burbank Middle School (BMS) 1 Hollywood Drive, Lancaster, MA.

The school was visited by Cory Holmes, Environmental Analyst of the Emergency Response/Indoor Air Quality (ER/IAQ) Program on June 10, 2005 to conduct an assessment. Mr. Holmes was accompanied during the assessment by Mr. Michael Sireci of the MTA and Mr. William Brookings, Health Agent, Nashoba Associated Boards of Health.

The school is a two-story red brick building constructed in 1974 and renovated in 2002. Occupants reported that for the last several years, dark staining that appeared to be softened mastic adhered to floor tiles and/or mold growth has occurred in several classrooms during hot, humid weather. This assessment primarily focused on possible mold growth and stained floor tiles associated with this phenomenon.

Methods

Visual inspection for microbial growth was conducted on floor tiles. Water content of the vinyl floor tile was measured with a Delmhorst, BD-2000 Model, Moisture Detector with a Delmhorst Standard Probe. Moisture tests of vinyl floor tile were conducted in both stained and unstained tile for comparison as well as in areas not affected. Air tests for carbon dioxide, temperature and relative humidity using a TSI, Q-Trak, IAQ Monitor, Model 8551. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. Screening for total volatile organic compounds (TVOCs) was conducted using a Thermo Environmental Instruments Inc., Model 580 Series Photo Ionization Detector (PID).

Results

The school houses grades 6-8 and has a student population of approximately 240 and a staff of approximately 45. For the most part tests were taken under normal operating conditions, however many classrooms were unoccupied due to end of the year activities. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were above 800 parts per million parts of air (ppm) six of nineteen areas surveyed, indicating inadequate air exchange in these areas. It is also important to note that a number of areas with carbon dioxide levels below 800 ppm were sparsely populated, unoccupied and/or had windows open, which can greatly reduce carbon dioxide levels. Therefore carbon dioxide levels would be expected to be higher with full occupancy. It is also important to note that classrooms are equipped to provide chilled air in warm weather, which limits outside air intake on hot, humid days (as was the case during the assessment). Limiting outside air intake can contribute to an increase in carbon dioxide levels.

Fresh air in classrooms is supplied by a unit ventilator (univent) system (Picture 1). Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building (Picture 2) and return air through an air intake located at the base of each unit (Figure 1). Fresh and return air are mixed, filtered, heated or cooled and provided to classrooms through an air diffuser located in the top of the unit. Adjustable louvers control the ratio of outside to recirculated air. As mentioned, during the air conditioning season, outside air is limited in order to maximize cooling and decrease humidity. Univents were operating in all of the areas surveyed. Obstructions to airflow, such as plants, books and other items stored on univents were seen in some areas (Picture 3). In order for univents to provide fresh air as designed, units must be activated while rooms are occupied and air diffusers should remain free of obstructions. The mechanical exhaust ventilation system consists of ceiling-mounted exhaust vents (Picture 4) ducted to rooftop motors, which were also operating during the assessment.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The date of the last balancing of these systems was not available at the time of the assessment, but should have occurred during renovations in 2002.

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please see Appendix A of this assessment.

Temperature measurements ranged from 69^{o} F to 77^{o} F, which were within or very close to the lower end of the MDPH recommended comfort guidelines in all areas surveyed. The MDPH recommends that indoor air temperatures be maintained in a range of 70 ^{o} F to 78 ^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity ranged from 51 to 88 percent, which was above the MDPH recommended comfort range the majority of areas during the assessment. The MDPH recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. The assessment occurred on a day of high outdoor relative humidity (89%). The highest humidity reading was measured in classroom D-124 (88%), which had its windows open (Picture 5). In comparison, classroom D-135 (a similar classroom) measured 64 percent with its windows shut, a difference in relative humidity of 24 percent.

Moisture removal is important since the sensation of heat conditions increases as relative humidity increases (the relationship between temperature and relative humidity is called the heat index). As indoor temperatures rise, the addition of more relative humidity will make occupants feel hotter. If moisture is removed, the comfort of the individuals is increased. While temperature is mainly a comfort issue, relative humidity in excess of 70 percent for extended periods of time can provide an environment for mold and fungal growth (ASHRAE, 1989). During periods of high relative humidity (late spring/summer months), windows and exterior doors should be closed to keep moisture out when the HVAC system is air conditioning mode. During the heating season, relative humidity levels would be expected to drop below the recommended comfort range. The sensation of dryness and irritation is common in a low relative humidity environment.

For buildings in New England, periods of low relative humidity during the winter are often unavoidable.

Microbial/Moisture Concerns

As previously discussed, the assessment was requested due to occupant concerns of stained floor tiles believed to be mold growth. MDPH staff examined stained tiles in affected classrooms. A black gum-like substance was observed on and around seams of floor tiles, which looked like mastic that had oozed from beneath the tiles (Pictures 6 and 7). It was reported by Mr. Sireci that samples of this material had been taken, analyzed and identified as having mold growth. MDPH staff recommended at the time of the assessment that the material be cleaned and disinfected as a temporary measure.

Occupants believed that the suspected mold growth was a result of water infiltration through the foundation due to a high water table in the area. It could not be confirmed if a vapor retarder was installed beneath the slab to prevent the seepage of moisture from sub-slab areas through the floor. Without a vapor retarder moisture can be drawn upward through the concrete slab by hydrostatic pressure and/or capillary action. Moisture can dissolve alkalis in concrete to form a solution, which can raise pH levels beneath flooring that can lead to the breakdown of adhesives (Donnelly G., 2005).

The staining appeared to be more prevalent in high traffic areas in classrooms versus those in low traffic areas. Stained tiles also appeared to be more prevalent in specific areas that had excess mastic leaking/oozing from around tile seams. Since this material is sticky in nature, it may collect dirt, dust and debris, which can provide media for mold growth, especially if wetted repeatedly (e.g., mopping, high humidity over an extended period/several days). It is possible that the mastic may have been applied incorrectly and/or not according to specifications (e.g., concrete not sufficiently cured), resulting in loss of adhesive integrity.

Although water infiltration may be a possible source of moisture impacting floor tiles, high relative humidity during summer months also appears to be a likely source for moisture in the building. Pathways were identified in a number of areas that allow for uncontrolled outside air into the building (see below). Classroom D-135, a corner classroom (Figure 2), had the most prevalent tile staining. During the assessment a number of conditions were observed that could exacerbate the introduction of humid outside air. Directly adjacent to room D-135 is the corridor to the rear exit (Picture 8). The doors are not airtight and had significant spaces below and around the doors that allow for outside air infiltration into the corridor (Picture 9). Once humid outside air is in the corridor, it can be drawn into the classroom by the ceiling-mounted exhaust vent, which is located near the hallway door (Picture 10). This particular door also had significant spaces beneath it (Picture 11). Finally, the hallway door was propped open during the assessment and a box fan was positioned in a manner that would actually draw humid air into the classroom from the hallway (Picture 12).

To determine if affected tiles had higher moisture content compared to unaffected tiles, moisture tests were conducted. As described earlier in the Methods section of this report, the tips of a moisture detector probe were inserted into stained and clean tiles. No elevated moisture measurements were recorded, however these measurements are limited to conditions on the day of the assessment.

In addition to floor tiles, several other potential sources of mold growth were identified. Plants were noted in several classrooms and in close proximity to univent air intakes outside the building (Pictures 1 and 2). Plants can be a source of pollen and mold, which can be respiratory irritants for some individuals. Plants should be properly maintained and equipped with drip pans. Plants should also be located away from ventilation sources (e.g., air intakes, univent diffusers) to prevent the entrainment and/or aerosolization of dirt, pollen or mold.

Univents that have air conditioning capabilities customarily are equipped with condensation collection pans and drains. One such drain in the school's courtyard was observed emptying water against the foundation (Picture 13). Excessive exposure to water of exterior brickwork can result in damage over time and provide a source of water penetration.

In several classrooms, spaces between the sink countertop and backsplash were noted (Picture 14). Improper drainage or sink overflow could lead to water penetration of countertop wood, the cabinet interior and behind cabinets. Like other porous materials, if these materials become wet repeatedly they can provide a medium for mold growth.

Other IAQ Evaluations

Indoor air quality can be negatively influenced by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants. Common combustion emissions include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (μm) or less

(PM2.5) can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the school environment, MDPH staff obtained measurements for carbon monoxide and PM2.5.

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. Several air quality standards have been established to address carbon monoxide and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

The American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE) has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from six criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2000a). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS levels (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2000a).

Carbon monoxide should not be present in a typical, indoor environment. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. On the day of assessment, outdoor carbon monoxide concentrations were non-detect (ND). Carbon monoxide levels measured in the school were also ND (Table 1).

The US EPA has established NAAQS limits for exposure to particulate matter. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. The NAAQS originally established exposure limits to particulate matter with a diameter of 10 μm or less (PM10). According to the NAAQS, PM10 levels should not exceed 150 microgram per cubic meter ($\mu g/m^3$) in a 24-hour average (US EPA, 2000a). These standards were adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, US EPA proposed a more protective standard for fine airborne particles. This more stringent PM2.5 standard requires outdoor air particle levels be maintained below 65 $\mu g/m^3$ over a 24-hour average (US EPA, 2000a).

Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, MDPH uses the more protective proposed PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor environment. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. Outdoor PM2.5 concentrations were measured at 54 $\mu g/m^3$ (Table 1). PM2.5 levels measured in the school were between 17 to 46 $\mu g/m^3$, which were below outdoor measurements and the NAAQS of 65 $\mu g/m^3$ (Table 1). Frequently, indoor air levels of particulates can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur in schools can generate particulates during normal operation. Sources of indoor airborne particulate may include but are not limited to particles generated during the operation of fan belts in the HVAC system, cooking in the cafeteria stoves and microwave ovens; use of photocopiers, fax machines and computer printing devices, operating an ordinary vacuum cleaner and heavy foot traffic indoors.

Indoor air quality can also be negatively influenced by the presence of materials containing volatile organic compounds (VOCs). VOCs are carbon-containing substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to determine whether VOCs were present in the building, air monitoring for TVOCs was conducted. An outdoor air sample was taken for comparison. Outdoor TVOC concentrations were ND. Indoor TVOC concentrations were also ND (Table 1).

Please note, TVOC air measurements are only reflective of the indoor air concentrations present at the time of sampling. Indoor air concentrations can be greatly impacted by the use of TVOC containing products. In an effort to identify materials that can potentially increase indoor TVOC concentrations, MDPH staff examined classrooms for products containing these respiratory irritants. Several classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain VOCs, such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat.

Cleaning products were also found on countertops and in unlocked cabinets beneath sinks in some classrooms. Like dry erase materials, cleaning products contain VOCs and other chemicals that can be irritating to the eyes, nose and throat of sensitive individuals.

In an effort to reduce noise from sliding chairs, tennis balls had been sliced open and placed on chair legs (Picture 15). Tennis balls are made of a number of materials that are a source of respiratory irritants. Constant wearing of tennis balls can produce fibers and cause TVOCs to off-gas. Tennis balls are made with a natural rubber latex bladder, which becomes abraded when used as a chair leg pad. Use of tennis balls in this manner may introduce latex dust into the school environment. Some individuals are highly allergic to latex (e.g., spina bifida patients) (SBAA, 2001). It is recommended that the use of materials containing latex be limited in buildings to reduce the likelihood of symptoms in sensitive individuals (NIOSH, 1997). A question and answer sheet concerning latex allergy is attached as Appendix B (NIOSH, 1998).

Wood dust and debris were observed around wood working machines and on flat surfaces in the technical education (tech-ed) room. The tech-ed room was outfitted with ductwork to draw materials into a wood dust collection system. However, not all the equipment was ducted. MDPH staff were informed that the system is seldom used because the switch to activate the system is located outside (Picture 16). Wood dust can be irritating to the eyes, nose, throat and respiratory system.

Finally, occupants in room D-132 reported ant infestation. A number of live and dead ants were observed at the base of the interior wall of the classroom. MDPH staff observed conditions on the exterior wall directly outside this area and found ant mounds against the foundation (Picture 17). Ants were observed entering the building through cracks in the foundation in this area (Picture 18).

Conclusions/Recommendations

As discussed, it could not be confirmed if a vapor retarder was installed beneath the slab during construction. Vapor retarders or barriers are important to prevent sub-slab moisture (from groundwater, soil, etc.) from entering the slab and creating water infiltration problems. However, once the concrete slab is poured the opportunity is lost; therefore other mitigation strategies must be considered. A subsequent conversation with Bill Spratt, Facilities Director for the Nashoba Regional School District, revealed that plans were in place to improve drainage around the building to relieve hydrostatic pressure and prevent water infiltration that is believed to be the cause of failing floor tiles. The project is tentatively scheduled to be completed prior to the upcoming school year.

Other conditions may exist however, that could account for the introduction of moisture indoors as discussed previously in this report. In view of the findings at the time of the assessment, the following recommendations are made:

Flooring Recommendations

1. Continue with plans to improve drainage around the building to prevent water infiltration damaging floor tiles.
2. Consider removing several tiles in various areas to determine if visible moisture and/or microbial growth are present. If so, the removal of all affected tiles may be

necessary and should be followed by cleaning with an appropriate antimicrobial agent.

3. If continued moisture accumulation/damage to floor tiles in the building recurs after drainage improvements, consideration should be given to having a building engineer examine other potential remediation/prevention strategies.
4. Consider contacting a reputable flooring contractor to remove/replace old tiles and mastic. Slab should be completely cleaned, prepped and sealed using a proper sealant.

General Indoor Air Quality Recommendations

1. Keep windows closed during hot, humid weather to maintain indoor temperatures and to avoid condensation problems when air conditioning is activated.
2. Close classroom doors to maximize air exchange.
3. Ensure univent air intake controls are adjusted to allow the introduction of fresh air.
4. Remove all blockages from univents to ensure adequate airflow.
5. Confirm whether the ventilation systems were balanced as part of the 2002 renovations. If they have not been balanced, consult a ventilation engineer concerning balancing/recalibration of the systems. Ventilation industrial standards recommend that mechanical ventilation systems be balanced every five years (SMACNA, 1994).
6. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced

when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (e.g., throat and sinus irritations).

7. Replace/remove water-damaged ceiling tiles. Examine the area above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.
8. Extend condensation drains in courtyard away from building.
9. Move plants away from univents in classrooms. Ensure all plants are equipped with drip pans. Examine drip pans for mold growth and disinfect areas of water leaks with an appropriate antimicrobial where necessary.
10. Remove plant growth from the vicinity of exterior walls and univent air intakes around the perimeter of the building.
11. Contact a masonry firm or general contractor to repair holes/breaches in exterior walls/joints to prevent water penetration, drafts and pest entry.
12. Seal areas around sinks to prevent water-damage to the interior of cabinets and adjacent wallboard.
13. Consider discontinuing the use of tennis balls on chair legs to prevent latex dust generation. Alternative “glides” can commonly be purchased from office supply stores; see Picture 19 for an example.
14. Store cleaning products properly and out of reach of students.

15. Operate wood dust collection system as needed. Consider connecting equipped that is not ducted to the system. Contact a licensed electrician to examine the system to install activation controls *indoors*.

16. Consider adopting the US EPA document, "Tools for Schools", to maintain a good indoor air quality environment on the building. This document can be downloaded from the Internet at: http://www.epa.gov/iaq/schools/index.html.

17. Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. These materials are located on the MDPH's website at http://www.state.ma.us/dph/beha/iaq/iaqhome.htm.

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Picture 1

Classroom Univent, Note Plants on top of Univent near Air Diffuser

Picture 2

Univent Fresh Air Intake, Note Plant Growth

Picture 3

Univent Obstructed by Various Items

Picture 4

Classroom Exhaust Vent

Picture 5

Open Windows in Classroom, Note Air Conditioning was Operating

Picture 6

Dark Staining on/around Floor Tiles

Picture 7

Dark Staining on/around Floor Tiles

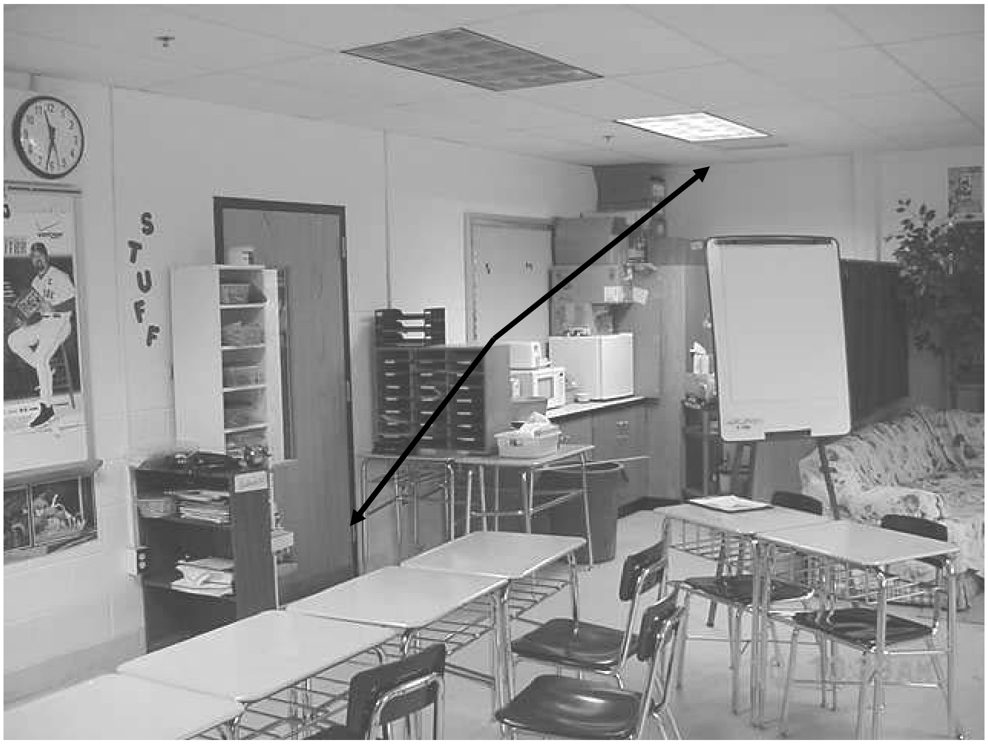
Picture 8

Exterior Doors outside Room D-135

Picture 9

Interior Hallway Doors in Corridor outside Room D-135, Note Spaces beneath Doors

Picture 10

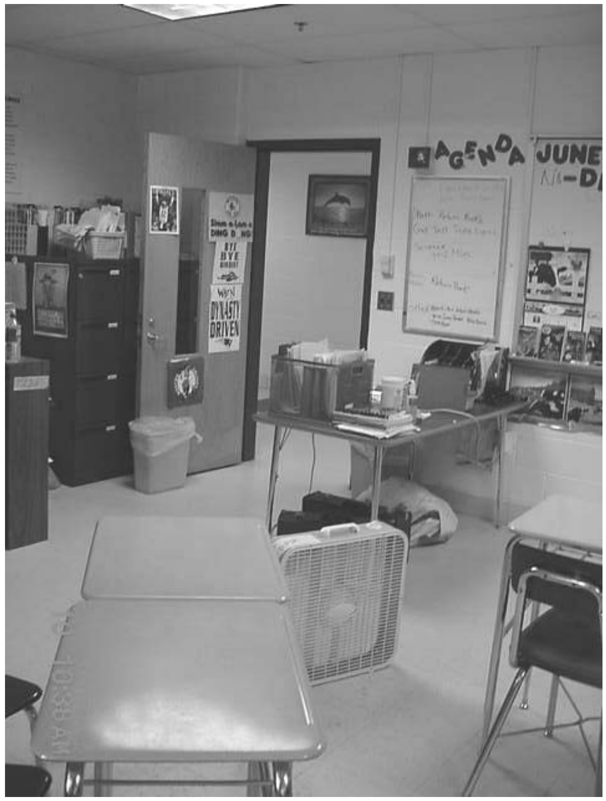


Proximity of Hallway Door and Ceiling-Mounted Exhaust Vent in Room D-135

Picture 11

Close-Up of Space beneath Hallway Door in Preceding Picture (D-135)

Picture 12



Classroom D-135 Door Propped open, Note Fan Positioned to Draw Air into the Classroom

Picture 13

Wet Tarmac (Dark Area) beneath Univent Condensation Drain

Picture 14

Breach between Sink Countertop and Backsplash

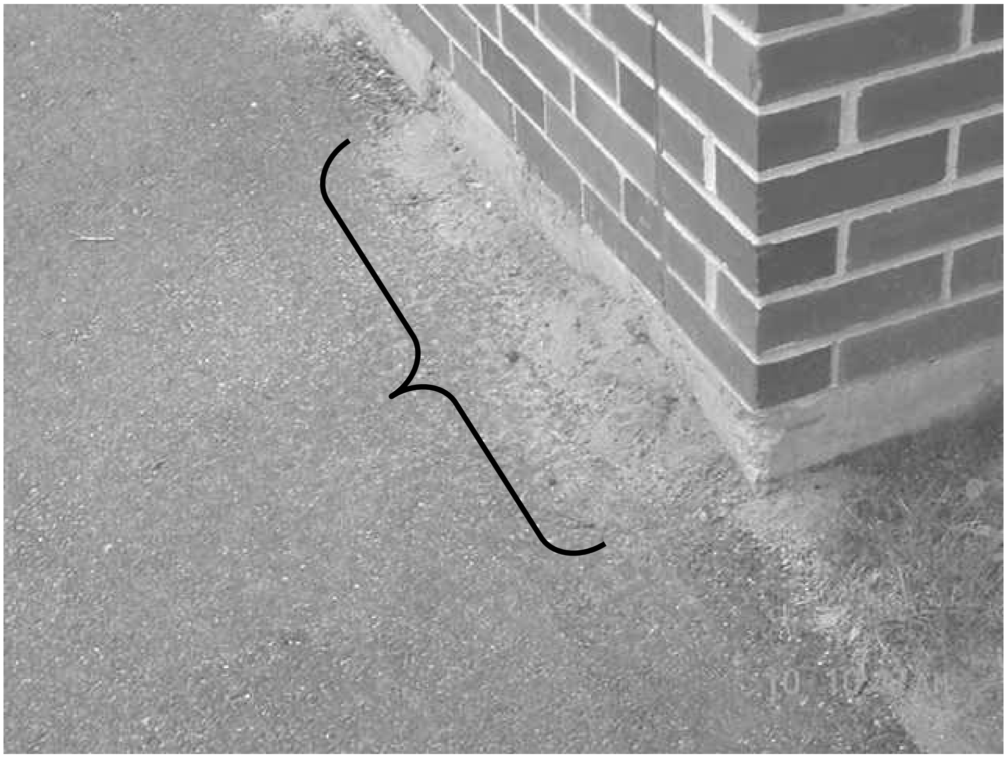
Picture 15

Tennis Balls on Chair Legs

Picture 16

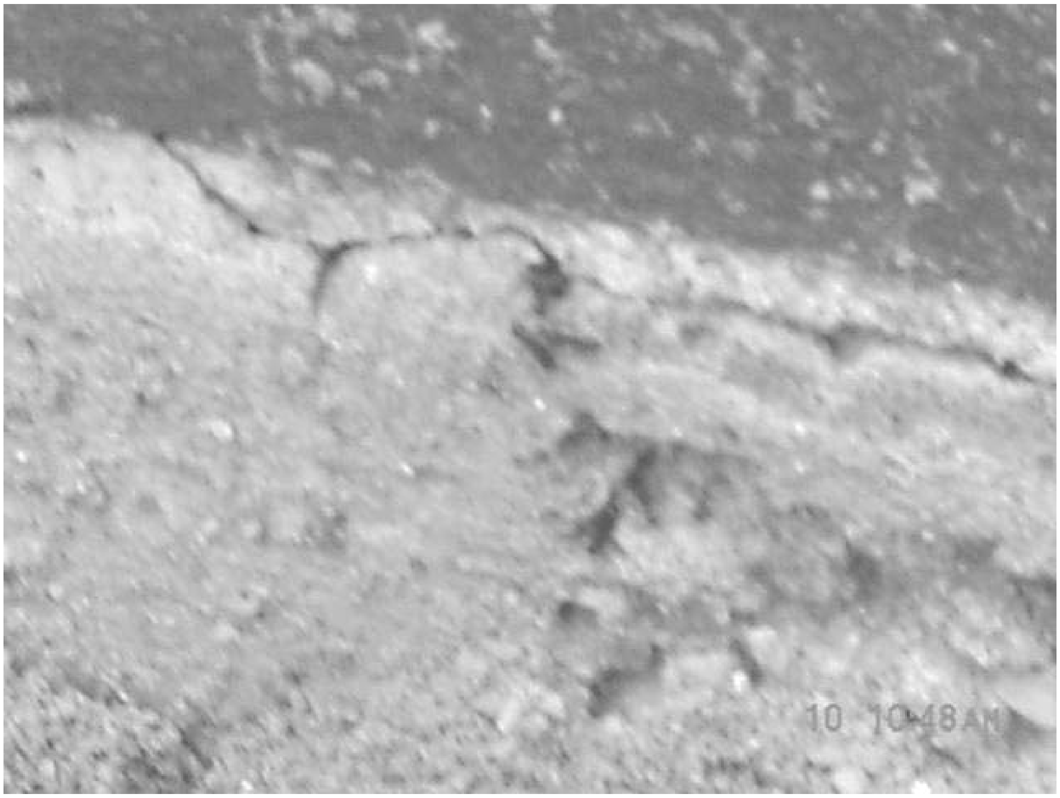
Activation Panel on Wood Dust Collector (Outside Building)

Picture 17



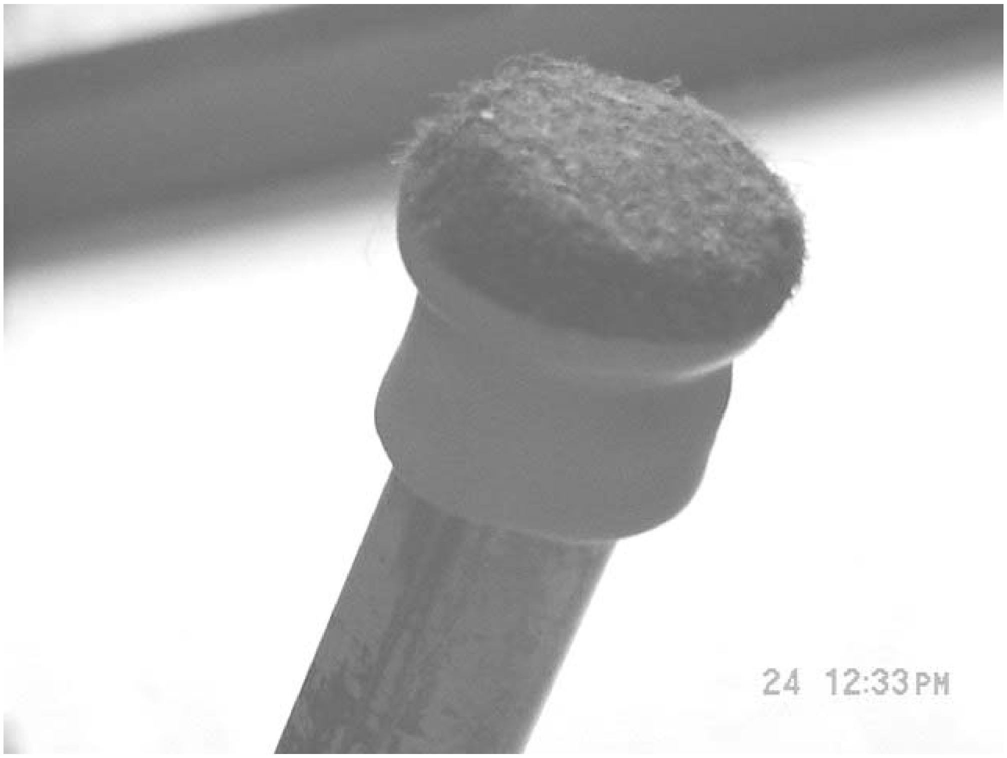
Ant Hills against Foundation

Picture 18



Close-Up of Ants Entering Building through Crack in Foundation

Picture 19



"Glides" for Chair Legs that can be used as an Alternative to Tennis Balls

Luther Burbank Middle School

1 Hollywood Drive, Lancaster, MA 01523

Indoor Air Results

June 10, 2005

Table 1

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
Background		88	89	431	ND	ND	54				Comments : Hot, humid, mostly cloudy, SW winds 10-15 mph.
D-135	0	75	64	590	ND	ND	19	Y # open: 0 # total: 6	Y univent plant(s)	Y ceiling	Hallway DO, NC floor, AP, DEM, PF, UF, dehumidifier, Comments : spaces under hallway door, fan-on/door open.
D-133	1	71	58	527	ND	ND	20	Y # open: 0 # total: 3	Y univent	Y ceiling	Hallway DO, NC floor, DEM.
D-136	8	71	60	733	ND	ND	23	Y # open: 0 # total: 6	Y univent	Y ceiling	Hallway DO, breach sink/counter, DEM.
library	68	72	59	1005	ND	ND	17	N	Y ceiling	Y ceiling	UF

ppm = parts per million
µg/m3 = micrograms per cubic meter

AD = air deodorizer
AP = air purifier
aqua. = aquarium
AT = ajar ceiling tile
BD = backdraft
CD = chalk dust
CP = ceiling plaster
CT = ceiling tile
DEM = dry erase materials
design = proximity to door
FC = food container
G = gravity
GW = gypsum wallboard
M = mechanical
MT = missing ceiling tile
NC = non-carpeted
ND = non detect
PC = photocopier
PF = personal fan
plug-in = plug-in air freshener
PS = pencil shavings
sci. chem. = science chemicals
TB = tennis balls
terra. = terrarium
UF = upholstered furniture
WD = water damage
WP = wall plaster

Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Luther Burbank Middle School

1 Hollywood Drive, Lancaster, MA 01523

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June 10, 2005

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (μg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
C-169	19	71	51	912	ND	ND	21	N	Y univent	Y ceiling	Hallway DO, DEM, UF.
C-176	16	69	52	957	ND	ND	21	Y # open: 0 # total: 3	Y univent plant(s)	Y ceiling	Hallway DO, #WD-CT : 2.
C-180	15	69	62	955	ND	ND	21	Y # open: 0 # total: 3	Y univent	Y ceiling	Hallway DO, cleaners.
C-179	16	69	58	994	ND	ND	22	Y # open: 0 # total: 3	Y univent	Y ceiling	Inter-room DO, DEM.
C-178	15	70	63	859	ND	ND	23	Y # open: 0 # total: 3	Y univent plant(s)	Y ceiling	Hallway DO,
cafeteria	0	69	61	467	ND	ND	27	N	Y wall	Y wall	Hallway DO,

ppm = parts per million
μg/m3 = micrograms per cubic meter

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Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Luther Burbank Middle School **Indoor Air Results**

1 Hollywood Drive, Lancaster, MA 01523 **June 10, 2005**

Table 1

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
D-117	1	72	75	486	ND	ND	24	Y # open: 0 # total: 3	Y univent	Y ceiling	Hallway DO, DEM, cleaners.
D-123	0	71	69	419	ND	ND	28	Y # open: 0 # total: 3	Y univent	Y ceiling	Hallway DO, plants.
D-126	1	71	71	434	ND	ND	26	Y # open: 0 # total: 3	Y univent plant(s)	Y ceiling	Hallway DO,
D-124	1	77	88	487	ND	ND	46	Y # open: 3 # total: 3	Y univent plant(s)	Y ceiling	Hallway DO, DEM, cleaners.
C-185	2	73	61	594	ND	ND	26	Y # open: 0 # total: 3	Y univent	Y ceiling	Hallway DO, DEM.

ppm = parts per million
µg/m3 = micrograms per cubic meter

AD = air deodorizer
AP = air purifier
aqua. = aquarium

AT = ajar ceiling tile
BD = backdraft
CD = chalk dust
CP = ceiling plaster
CT = ceiling tile
DEM = dry erase materials

design = proximity to door
FC = food container
G = gravity
GW = gypsum wallboard
M = mechanical
MT = missing ceiling tile

NC = non-carpeted
ND = non detect
PC = photocopier
PF = personal fan
plug-in = plug-in air freshener
PS = pencil shavings

sci. chem. = science chemicals
TB = tennis balls
terra. = terrarium
UF = upholstered furniture
WD = water damage
WP = wall plaster

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									Supply	Exhaust	
tech ed	1	73	66	600	ND	ND	24	Y # open: 0 # total: 0	Y univent	Y ceiling	Hallway DO, Comments : wood dust collector, some machines ducted.
C-170	0	73	58	574	ND	ND	20	Y # open: 0 # total: 3	Y univent items plant(s)	Y ceiling	Hallway DO, DEM, TB, aqua/terra.
D-130	0	72	72	566	ND	ND	21	Y # open: 0 # total: 3	Y univent	Y ceiling	Hallway DO, DEM.
D-132	1	72	65	685	ND	ND	22	N	Y ceiling	Y ceiling	Hallway DO, DEM, pests, Comments : ants.

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